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DISEASES OF STONE FRUITS ON THE MARKET

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PEACH BROWN-ROT

THIS BULLETIN is issued to give specific information on the various diseases which occur on stone fruits during marketing.

It has become of increasing interest to growers, shippers, carriers, and receivers of stone fruits to know the names and the causes of these diseases, how they behave in transit or storage, and how they can be controlled.

This bulletin gives most attention to the market phases of the disease problem, but field phases are considered when reference to them helps to explain conditions which may arise during the marketing process.

It is based partly on publications of State and Federal investigators and partly on information gained by six years of inspection at terminal markets by the Food Products Inspection Service of the Bureau of Agricultural Economics, United States Department of Agriculture. One of the features of this service is to show on the inspection certificate the name of the disease that occurs in the car or storage lot. With the name known the principal facts regarding the disease from the market standpoint can be found in this bulletin.

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DISEASES OF STONE FRUITS ON THE MARKET

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ALTERNARIA ROT OF CHERRIES

Cause.—A fungus (*Alternaria* sp.).

Fruits affected.—Alternaria rot occurs on both sweet and sour cherries, but has not been seen on other stone fruits.

Geographic distribution and varieties affected.—The disease has been found on sweet cherries as follows: On Bing from Yakima and Wenatchee, Wash.; on Lambert from Emmett, Idaho; on Windsor from northern Michigan. Varieties of sour cherries which sometimes show the disease are Montmorency and Early Richmond, both from southern Michigan.

Description of the disease.—The rot on the sweet cherry occurs as a firm, brown, decayed spot in the shape of a cone with its apex extending inward from the skin toward the pit. This brown mass is made up of dead tissue, interpenetrated and apparently held together by the fungous threads. It is much firmer than the surrounding healthy tissue, so that if the skin is carefully removed the affected tissue underneath can often be lifted out intact. The skin which overlies the affected area is covered with an olive-green growth of spore-bearing threads; sometimes this spore-bearing layer is hidden under a growth of threads which are white and fluffy.

The symptoms on the sour cherry are quite different. The only similarity is the olive-green layer of sporulating mycelium growing on the epidermis, and even this soon becomes soaked with juice and looks black and matted. In the early stages of the disease there is apparently so little penetration of the fungus below the epidermis that the whole surface of a cherry may be covered with the olive-green growth before the flesh is decayed near the pit. When the tissue decay does take place it is light brown and not nearly as firm as that in the sweet cherry. No fluffy growth of the fungus has been observed on sour cherries. In general, the disease on sour cherries is

characterized by a decayed epidermis covered with a black water-soaked mat of spore-bearing fungous threads. The stems of affected cherries (both sweet and sour varieties) are nearly always dead and often contain molds of various kinds, particularly those which are known to attack only dead tissue.

Nothing is known as to where Alternaria rot originates or how it is affected by conditions in transit. Losses caused by it are usually small, though a few carloads of sweet cherries have been seen in which the damage amounted to 25 per cent.

BACTERIAL SPOT OF PEACHES, APRICOTS, NECTARINES, AND PLUMS

Cause.—A bacterium (*Bacterium pruni*).

Fruits affected.—Bacterial spot is an orchard disease which affects fruits, twigs, and leaves of the peach, apricot, nectarine, and plum. On all of these it causes most damage by its attack on the leaves, but often blemishes the fruit so badly that the market value of the crop is greatly reduced.

Geographic distribution and varieties affected.—This disease has been reported from practically the whole of the eastern United States. It is usually more serious in southern fruit-growing sections, but is sometimes seen as far north as Nebraska, Michigan, and New York. All varieties of peaches are susceptible to its attack, though of the more important commercial varieties J. H. Hale, Elberta, Carman, Sneed, and Champion generally suffer more damage than do Hiley, Belle, Early Crawford, and Salwey. The varieties of apricots most severely affected are Royal, Sweet Russian, Peach, and Breda; of nectarines, New White, Stanwick, and Victoria. American varieties of plums are rarely attacked, while the Japanese varieties, especially Abundance and Burbank, often show serious injury.

Description of the disease.—Symptoms of the disease are about the same on all varieties of stone fruits, the chief difference being that they are more pronounced on some than on others. Spots on the leaves show first as small, nearly transparent, water-soaked areas, which later turn dark, become dry and brittle, and finally fall out, producing the shot-hole appearance, which has given rise to one of the names applied to this disease. (Fig. 1.) Spots on the twigs appear in their final stage as slightly sunken purplish black to black areas, half an inch to 2 inches in length, and extending half to two-thirds the way around the twig.

On the fruit the disease shows first as small, very slightly discolored spots, which later enlarge and grow darker. As the disease progresses affected tissues dry out and crack, the cracks becoming so marked in later stages, when they deepen and run together, that they constitute a serious blemish and sometimes render the fruit unmarketable. On peaches and nectarines, where the cracking is more severe, it is frequently followed by infection with blue-mold and other decay fungi. In the relatively few cases of the disease which have been found on the market both of these effects—cracking, with decay following—have been seen.

Control.—Field experiments in southern peach orchards indicate that the disease can be held in check there by proper pruning, cultivation, and fertilization, all of these being practices which keep the trees vigorous and healthy. Fertilization, especially with nitrate of

soda, has given better results than either pruning or cultivation practiced alone. Spraying has very little effect on the disease.[1]

BLUE-MOLD ROT OF CHERRIES AND PEACHES

Cause.—A fungus (*Penicillium* sp.).

Description and fruits affected.—Blue-mold rot is rarely found on stone fruits in the orchard, but sometimes damages them severely in transit. On all of them it is characterized by the usual scanty growth of mold, white at first and turning bluish green later, which grows along the edges of cracks in the rotten spots or generally over the surface of such spots; also by a slight browning of affected tissues and by a soft, more or less watery condition, which in peaches is very much like that produced in apples. (Fig. 2.)

The rot is more common on cherries than on any other stone fruit, although it occasionally appears in rather high percentages on

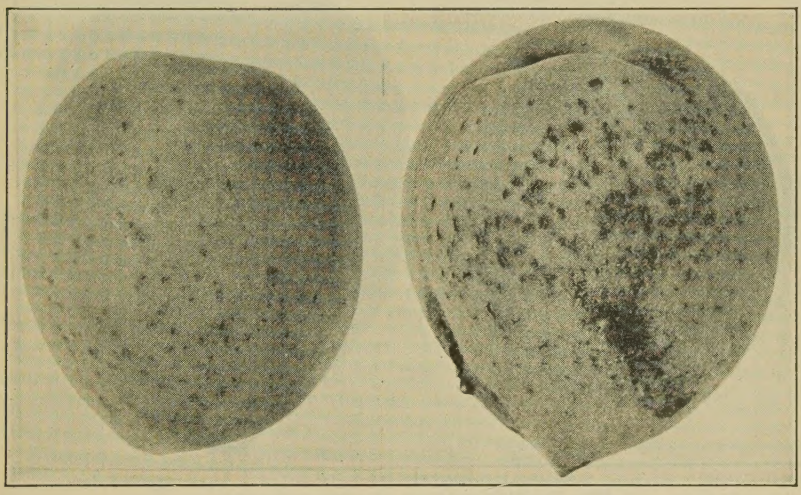

FIG. 1.—Bacterial spot of peach

peaches from California and the Northwest. It is extremely rare on peaches from other sections.

The fungus is quite common in nature on dead or decaying material of various kinds, producing there immense numbers of spores—minute bodies which serve the purpose of seeds and are the chief means by which the fungus is spread. When carried by wind, insects, or other agencies, they lodge on all plant parts above ground throughout the orchard, many of them, of course, on the fruit. If conditions are favorable they may cause decay at once, though usually such conditions do not exist until the fruit is packed and on the way to market.

Spores.—With spores present on the fruit, conditions that lead to decay, either in the field or in transit, are as follows: Water on the fruit surface, without which the spores can not germinate; skin

[1] For further information on this subject, see U. S. Dept. Agr. Bul. 543, Control of Peach Bacterial Spot in Southern Orchards, by J. W. Roberts.

breaks, which furnish easy entrances for the fungous threads produced by this germination; and temperatures of 50° F. or above, without which spore germination and growth and penetration by the threads takes place very slowly, if at all. After penetration has occurred, temperature is of less significance, since the threads can then continue to grow and cause decay even though the temperature is lowered to 40° F. Growth is not entirely checked at 32° F.

Relation to orchard conditions.—In the orchard during the growing season, although temperatures are rarely unfavorable for the rot, moisture may be lacking, and skin breaks are almost sure to be absent unless the fruit is injured by insects or wind and hail. The fruit is immature and not susceptible to attack by any of the ordinary decay fungi until late in the season. For these reasons, therefore, blue-mold rot does not often occur in the orchard.

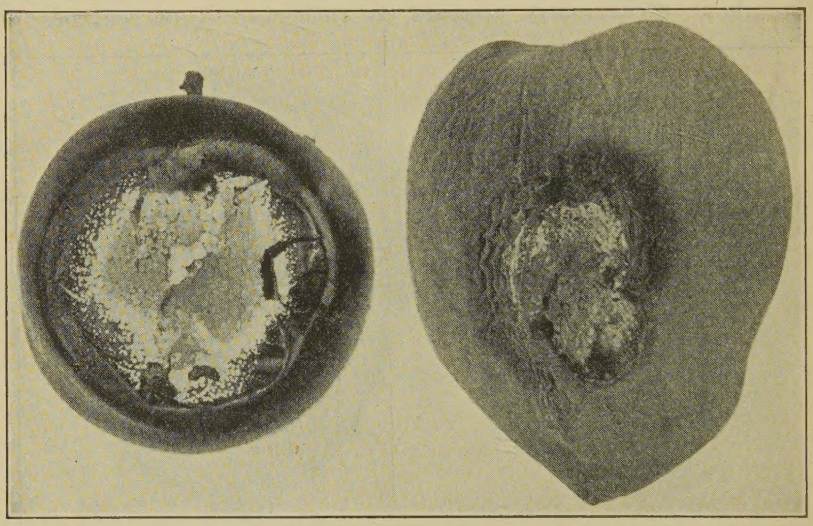

FIG. 2.—Blue-mold rot of plum and peach

Relation to conditions in transit.—Conditions in transit may be and often are distinctly favorable to the spread of the disease. Careless handling prior to loading or rough handling of the car in transit causes numerous skin breaks; rain or heavy dews at picking time or a moist atmosphere in the car causes the fruit surface to be moist when loaded or to become so soon afterward; the temperature may be high at first—above 50° F. at lowest—due to the loading of warm fruit and to delayed or inadequate icing. As a result, the few spots of decay already present develop further and new ones are started where injuries occur. Throughout the transit period temperatures considerably below 50° F.—between 40° and 45° F.—are necessary if heavy losses are to be prevented. These temperatures can be obtained only by the most careful attention to icing. The fruit can be cooled more quickly and kept cooler throughout the transit period by installing slatted false floors before loading, by stowing the load in such a way as to allow free circulation of air, and by salting the

ice. If such methods are used, it is well to install solid bulkheads to prevent freezing near the bunkers.

Even under these conditions the top of the load may be 5 to 10 degrees warmer than the bottom, a difference which is also found in cars with only the ordinary equipment. With false floors and salted ice the load cools so quickly that no part of it stays long at a temperature favorable to blue-mold rot; without them cooling goes on more slowly and the rot may get a start, not only at the top but lower down in the load, and may reach serious proportions by the time the car arrives at destination. Delay in transit increases the damage, because it gives the fungus a longer time in which to work.

Control.—Control of blue-mold rot depends on careful handling prior to loading and in transit, on prompt loading, on the proper stowing of the load, on as rapid cooling as possible to temperatures below 50° F., on the maintenance of such temperatures throughout the transit period, and on the prompt movement of the car. Whoever fails to provide his share of these conditions in the fullest measure possible is, to the extent of his failure, responsible for loss from blue-mold rot.

BROWN-ROT OF PEACHES, PLUMS, APRICOTS, AND CHERRIES

Cause.—A fungus (*Sclerotinia cinerea*).

Fruits affected.—Brown-rot is a disease primarily of stone fruits—peach, prune, plum, apricot, and cherry—although it sometimes occurs on pome fruits—apple, pear, and quince. It will be considered here only in reference to stone fruits.

Place of origin.—Brown-rot originates in the orchard, but may cause damage at any stage of the marketing process or even after the fruit reaches the consumer. In the orchard it occurs on blossoms, fruits, twigs, and limbs, the completeness of the attack depending to a considerable degree on which fruit is affected and on temperature and moisture conditions.

Spores.—The fungus which causes brown-rot winters over in diseased twigs and limbs and in dried-up rotten fruits (mummies); during wet weather in the growing season it produces, mainly on the mummies, immense numbers of spores, minute bodies which are easily distributed by wind, insects, or other agencies. The spores find lodgment everywhere, but are of greatest importance on the fruits, which are very susceptible to attack by the fungous threads produced when the spores germinate.

Spore germination.—Spore germination will not go on very rapidly unless the temperature is moderately high—50° F. or above—and there is water present on the surface with which the spores are in contact. Growth of the fungous threads is best only when the temperature is fairly high. Hence the development and spread of the disease in the orchard, particularly on the fruit, are closely associated with warm wet weather, although with high temperature a prolonged drizzly spell or a series of cloudy days with frequent showers is more dangerous than a heavy rain followed by clearing. But since summer temperatures in any peach section are usually much above the minimum required for the development of brown-rot, the chief determining factor in all sections is moisture. It thus

comes about very naturally that the rot is most prevalent and most destructive in southern peach-growing sections, considerably less so in sections farther north except during rainy weather, and almost negligible in the more arid portions of the West and Northwest.

Effect of maturity and fertilizers.—Immature fruits are rarely attacked in the field, but may sometimes suffer from the rot in transit. Ripe fruits are much more susceptible both in the field and in transit. Fruit produced on trees heavily fertilized with nitrate of soda or barnyard manure often shows increased susceptibility to the rot, especially if the application of fertilizer is made in a wet season on soil already rich.. Such treatment produces peaches that are coarse in texture and sappy, a condition which seems to make the fruit open to attack by the brown-rot fungus.

Effect of skin breaks.—Breaks in the skin due to careless handling, to wind and hail, to insect injury, or to the cracking that often accompanies scab all tend greatly to increase infection (the beginning of rot at new places). In fact, without skin breaks there is little danger of infection, except under conditions of moisture and temperature which are favorable to the growth of the fungus, as, for example, in the upper layers of a carload which becomes too warm in transit (see after side heading "Control in transit") and remains so for 12 to 24 hours or more. Under such conditions the fungus is apparently able to penetrate the uninjured skin of the fruit.

Chief among insects associated with brown-rot or concerned in the distribution of brown-rot spores is the plum curculio, the eggs of which on hatching produce the worms so often found in stone fruits. When worm and rot occur in the same fruit, infection probably took place at the egg-laying puncture through spores carried either by the insect or by the wind. When the rot occurs alone, infection may have taken place at a curculio feeding puncture, or some other skin break, or directly through the otherwise sound, undamaged skin. In the Northwest, stone fruits grown west of the Cascade Mountains sometimes become infected with the rot at injuries made by the syneta leaf-beetle.

Description of the disease.—The disease on the fruit appears at first as small circular brown spots, which under conditions favorable to infection (at temperatures of 60° to 80° F.) may enlarge so rapidly as to bring about complete decay in 24 to 48 hours. The spots at no stage are sunken, and the flesh remains firm. In late stages the skin turns dark brown or even black. The fungus grows at first entirely within the fruit, but finally breaks through the skin, forming small gray spore-bearing tufts, which may be scattered here and there over the rotten spot or may become so numerous and so crowded together as to give the whole spot a grayish appearance. (Fig. 3.) The new crop of spores is able to start the disease again on other fruits. These within a few days will develop another crop that can spread the disease still further, the process being limited only by weather and the length of life of the fruit.

Geographic distribution and losses.—In the Eastern and Southern States brown-rot occurs on all stone fruits; in California chiefly on apricots; in the humid sections of Washington and Oregon on all stone fruits, though only rarely on apricots and peaches. Of 1,614

cars of peaches from 24 States examined in 1919 by Federal inspectors, 1,149 showed brown-rot to the extent of about 20 per cent, or an average for the total of about 14 per cent. The average in 615 cars from Georgia was nearly 25 per cent, in 67 from Arkansas 10 per cent, and in 41 from New York 10 per cent. The average loss in 597 cars from Georgia in 1920 was 17 per cent and in 677 cars in 1921 11 per cent.

Control in the orchard.—Brown-rot in the orchard can be controlled by a combination spray of self-boiled lime-sulphur (for the fungus) and arsenate of lead (for the curculio), though if rainy weather prevails late in the season, especially at picking time, the rot will develop and spread to some extent in spite of even the best of spraying.[2]

Relation to weather.—Growers and shippers find that they frequently get a different outcome for the same methods of picking and packing the same variety and what seem to be the same conditions in transit. If the identity in treatment really exists, the difference

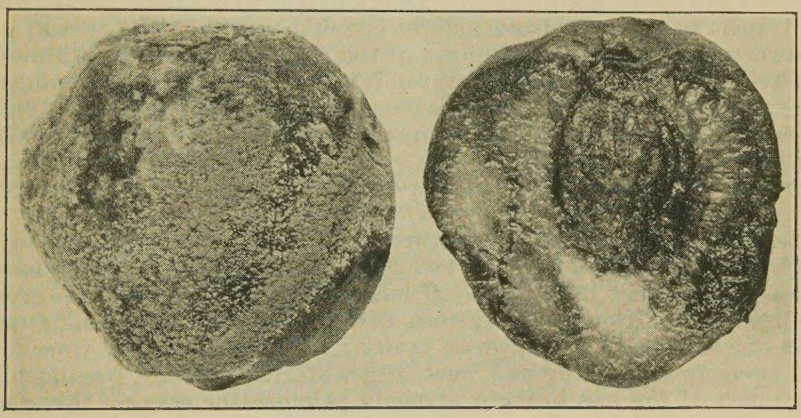

FIG. 3.—Brown-rot of peach

in final condition is almost entirely a matter of weather at shipping point. It may occasionally be due to differences in maturity.

Effect of wet weather.—Brown-rot occurs in practically all peach orchards of the southern and eastern United States, but much more commonly in wet than in dry weather. No particular point need be made of temperature, since in the regions named, as already stated, it is rarely a limiting factor at peach-picking time. In brown-rot territory, if wet weather prevails when the crop is harvested the disease and the spores of the fungus will be abundant in the orchard. Consequently some fruits which show small rotten spots are likely to be overlooked by the packers; or fruit may be packed in which decay (infection) exists, but not at such a stage that it is visible as discolored spots; or, as a third possibility, fruit is packed on which spores

[2] For further information on orchard control measures, see the following publications:
Farmers' Bul. 440, Spraying Peaches for the Control of Brown-Rot, Scab, and Curculio, by W. M. Scott and A. L. Quaintance.
N. Y. Cornell Agr. Exp. Sta. Cir. 26, Peach Cankers and Their Treatment, by R. A. Jeble.
U. S. Dept. Agr. Cir. 216, Controlling the Curculio, Brown-Rot, and Scab in the Peach Belt of Georgia, by O. I. Snapp, W. F. Turner, and J. W. Roberts.

have lodged despite the best efforts of the grower, but have not yet caused infection. If conditions in transit are favorable for infection, the rotten spots already present (whether visible or not) will enlarge, new ones will be formed by the germination of spores lodged on the fruit, and the load will arrive at destination showing much decay.

If the weather is dry at picking time brown-rot spores will be scarce, and there will be little or no infection, either visible or invisible, on the fruit. Consequently the chances are good that very little decay will develop in transit even under conditions which might allow much of it if the fruit had been picked during wet weather. This does not mean that peaches from brown-rot territory if harvested in wet weather are bound to rot in transit under good conditions. Rather, it means that too often the conditions provided are not the best and are not really adequate to hold brown-rot in check on fruit picked in wet weather and infected with this disease.

Control in transit.—In transit there is usually moisture enough present for spore germination. Development and spread of the rot in transit therefore depend mainly on temperature. The spread of brown-rot—that is, the beginning of the rot at new places—is almost entirely prevented by temperatures below 50° F. The development of rot already present is checked somewhat at 50° and to a still greater extent the lower the temperature goes, but is able to make some progress even at 32° F. The upper limit of safety, the temperature that will prevent serious loss during the ordinary transit time, is about 45°.

Loading hot fruit and delay in transit.—If fruit is loaded hot, say, with a temperature of 80° or 90° F. (or even higher, as sometimes happens), it may take 24 to 48 hours to cool below 50° F., even though well refrigerated. Such a delay in cooling and similar delays due to belated or otherwise faulty icing of the car give time for old spots to enlarge or new ones to get started and are responsible for much of the loss brought about in refrigerator cars by this disease. Transit delays increase the loss, for by giving the brown-rot fungus a longer time in which to work they either aggravate conditions that already exist or cause others which would not have arisen if the car had moved on time.

Relation between brown-rot and car temperature.—Brown-rot is practically always worse at the top of the load than at the bottom. The temperature at the top is usually higher, often 5 to 10 degrees and occasionally 20 degrees higher. It is evident, therefore, that the higher temperature at the top causes the rot to develop more rapidly and that the lower temperature at the bottom holds the rot in check. This difference in temperature between the top and the bottom is found, however, in both well-iced and poorly iced shipments. When the difference is small it should be considered merely the result of the way in which cooling takes place in refrigerator cars. When large it may mean any one or a combination of the following: (1) A poorly constructed car, (2) a car in need of repair, (3) poor transit icing, and (4) improper stowing of the load. It occurs even when special provisions are made to hasten cooling by the use of salted ice and slatted false floors. But under such conditions the spread between the top and the bottom temperatures is

cut down, and the whole load is cooled so rapidly that no part of it remains long at a temperature favorable to the disease.

Moisture and skin breaks in transit.—Next to temperature there are two other conditions—moisture and skin breaks—that are of importance in transit. Moisture, however, is practically always present, either because of rain or heavy dew at picking time or more often as a result of condensation on the fruit due to a moist atmosphere in the car and fluctuations in car temperature. Skin breaks result from careless handling prior to loading, or in transit, or from shifting and breakage due to improper stowing of the load.[3]

BRUISES

Cause.—Careless handling or improper packing.

Causes and their relation to rot.—Bruising may occur on all stone fruits, but is most common on peaches. It may be caused by careless handling in picking or packing; by packing too tightly, too high, or too loosely in the package; or by rough handling in transit.

If the bruising is only moderate, it blemishes the fruit; if severe, it causes skin breaks that let in various decay organisms. Peaches in particular bruise severely and are likely to suffer skin breaks if they are packed so high in the container that force is necessary to get the cover on. The riper the peaches the greater the damage.

Not to be confused with rot.—Bruises in peaches are sometimes mistaken for rot. To distinguish the two it is only necessary to remember that in bruises the flesh has a mottled brown and white appearance and the skin is not browned, while in rotten spots both skin and flesh are brown. The shade of brown varies somewhat with the kind of rot, being considerably darker for brown-rot than for either Rhizopus rot or blue-mold rot.

GRAY-MOLD ROT OF PEACHES

Cause.—A fungus (*Botrytis cinerea*).

Description of the disease.—Gray-mold rot is characterized by a light-brown discoloration of the skin and underlying flesh and a rather firm texture of affected tissues. The skin around the margin of the spots slips easily under pressure from the finger, somewhat as in Rhizopus rot, but the decayed tissue does not have the marked sour odor characteristic of Rhizopus rot. Gray-mold rot has no definite odor. Rotten spots often show on the surface a scanty white to gray fungous growth, with numerous gray bunches or clumps about a third or a fourth the size of a small pinhead on short branches of this growth. These bunches are composed of spores, the minute bodies by means of which the fungus is distributed and reproduced.

As a disease of stone fruits gray-mold rot is at present known only on peaches from California. Nothing is known about how the disease originates or how it is affected by conditions in transit. It

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[3] For further information on this subject, see the following publications:
U. S. Dept. Agr. Bull. 331, The Handling and Shipping of Fresh Cherries and Prunes from the Willamette Valley, by H. J. Ramsey.
Jour. Agr. Research, v. 22, p. 451-465, 1921. Temperature Relations of Stone-Fruit Fungi, by C. Brooks and J. S. Cooley.
In Jour. Agr. Research, v. 22, p. 467-477, 1921. Transportation Rots of Stone Fruits as Influenced by Orchard Spraying, by C. Brooks, J. S. Cooley, and D. F. Fisher.

is known, however, that the spores of gray mold are fairly common in most places where fruits are grown and that the fungus itself is able to develop and spread in transit even at the fairly low temperatures (40° to 45° F.) usually maintained in refrigerator cars. The development is slower, of course, the lower the temperature is kept. Much depends also (1) on the care with which the fruit is handled during the picking and packing process and in transit, (2) on the manner of stowing and bracing the load in the car, and (3) on whether the car is kept well iced during transit.

Losses from this disease in shipments of peaches seem to be small.

HAIL INJURY

Hail injury consists of irregular, more or less sunken spots, which often show dried-up fragments of the skin and flesh around the edges or on the surface. These spots differ from curculio injury in being larger and in showing little or no gummy exudate and no trace of larval burrows underneath. Because of the way in which they are produced, they generally occur on only one side of the fruit, whereas those due to curculios may be found on all sides. Injury by fruit beetles is sometimes mistaken for injury by hail or by curculios, but can be distinguished from either by the smooth flat layer of wound cork shown in the cavities. Damage by birds or grasshoppers occurs late in the season; hence is not likely to heal over before the fruit arrives on the market. Peaches and plums injured by hail late in the season are usually so severely damaged that they do not reach the markets.

PUSTULAR SPOT OF PEACHES

Cause.—A fungus (*Coryneum beijerinckii*).

Geographic distribution and fruits affected.—Pustular spot, also known as peach-blight, shot-hole, brown-spot, and winter blight, is a fungous disease which originates in the orchard. It occurs rather commonly on peaches in California, Colorado, and Utah, and is sometimes seen on this fruit in Michigan, Indiana, Ohio, Oregon, and New York. It attacks apricots in California, but not to any important extent elsewhere, though it has been noted on them in New York.

Description of the disease.—Spots on the fruit are at first purplish red, small, and distinct from each other. Later, as they enlarge, they show white centers surrounded by brown areas one-eighth to one-fourth of an inch in diameter (fig. 4), which by further extension may finally run together and form diseased patches covering a fourth or more of the fruit. Subsequent to this stage, cracks develop in the diseased areas and are sometimes followed by a flow of gum. Infection with brown-rot may occur at the spots, though usually the affected tissues have such a dry, corky texture that decay fungi do not readily attack them.

Relation to transit conditions.—The disease is sometimes seen on the market on peaches from California, Colorado, and Utah, and in some seasons is rather common on apricots from California. It does not spread in transit, but probably develops to some extent; that is, spots present at loading time probably enlarge slowly during

the transit period. The degree of enlargement will depend on the length of time required in transit and on the car temperature during this time. It will be less if the transit time is short and the temperature fairly low—45° to 50° F.—than if the temperature is above 50° F. and the transit time long—7 to 10 days.

Control.—Under ordinary conditions the disease can be controlled in the orchard by spraying with 5–5–50 Bordeaux mixture as soon as the leaves are off in the fall, or even before all of them are gone. When infection is common and severe, because of warm, rainy weather, it may be necessary to spray again in the spring, about a month ahead of blossoming time.[4]

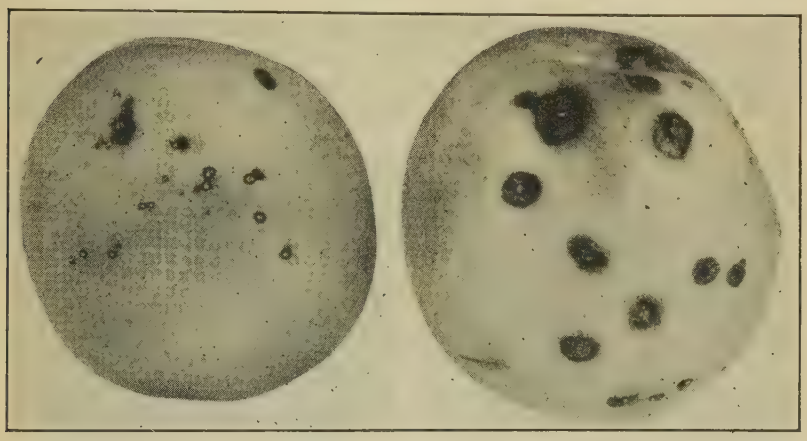

FIG. 4.—Pustular spot of peach

RHIZOPUS ROT

Cause.—A fungus (*Rhizopus nigricans*).

Description of the fungus.—The fungus Rhizopus, sometimes known as whiskers, has a wide distribution in nature and attacks practically all kinds of fruit, though it is not known to occur on citrus fruits and cranberries. Under ordinary conditions of moisture and temperature it is characterized by a heavy growth of long, rather coarse white threads and small spherical heads, which are white and glistening when first formed but later become black and dull; in dry, cool air only a scanty growth is produced, and the heads show as dense gray or black masses close against the fruit.

Description of the rot.—Rhizopus rot in peaches shows affected tissues rather light brown in color and by the time the peach is well decayed a soft condition of the flesh. At this stage the characteristic white growth and black spherical heads appear, which are easily distinguished from the grayish spore-bearing tufts of the brown-rot fungus (fig. 5). In Rhizopus rot the skin slips easily

[4] For further information on this subject, see the following publications:
Calif. Agr. Exp. Sta. Bul. 191, California Peach Blight, by R. E. Smith.
Oreg. Agr. Exp. Sta. Bul. 106, Spraying for Peach Fruit Spot, by A. B. Cordley and C. C. Cate.
Oreg. Agr. Exp. Sta. Bien. Crop Pest and Hort. Rpt., Diseases of Drupaceous Fruits, California Peach Blight and Fruit Spot, by H. S. Jackson.
Manual of Fruit Diseases, by L. R. Hesler and H. H. Whetzel.

from the diseased flesh, while in brown-rot the skin clings tightly to it.

In apricots, Rhizopus rot has much the same symptoms as in peaches. In plums, prunes, and cherries a soft, leaky condition appears that may or may not be accompanied by slight browning. In all of these fruits a strongly acid odor is usually noticeable when the rot becomes well advanced.

Spores.—In early stages of Rhizopus rot the fungus is entirely within the fruit; later on it grows to the outside, producing the coarse white growth and spherical heads already mentioned. These heads when they turn black contain minute bodies called spores, which, because of their relation to the propagation of the fungus, are of direct practical significance in the growing and handling of fruit. Being small and light, they are easily carried by the wind, by rain, by insects, and by other agencies, and are therefore common, no matter what precautions the grower may take, on the soil surface

FIG. 5.—Rhizopus rot of peach

and on all plant parts above ground in berry fields, vineyards, and orchards. They are of most importance on the surfaces of fruits, for the reason that under favorable conditions of moisture and temperature they germinate, producing fine fungous threads which enter the fruit and cause decay. When fruits lie near each other or touch, or when they touch the ground, the rot may be spread merely by the growth of the fungous threads, though even here the original source of the threads was a spore or spores.

Mainly a transit disease.—In warm wet weather Rhizopus rot is occasionally found on mashed or overripe peaches and other fruits in the orchard or around the packing house, but such occurrence gives no warrant for calling the rot a field disease; it is too unusual, too much dependent on special conditions. Most of the damage from this rot takes place in transit and storage, though the occurrence of such damage is no proof that the fruit was generally diseased when it left the packing house. There may have been a few slightly rotted

fruits in the package and a few so recently or so slightly infected that they showed no discoloration or marked softening; but the more plausible assumption is that despite the best efforts of the grower the fruit bore on its surface Rhizopus spores, which, because of conditions in storage or in transit favorable for spore germination and for the growth of the fungous threads, started the rot at new places after the load went into the car or the storage room. Such favorable conditions would, of course, hasten the growth of the mold in fruits already attacked and promote its further spread to others lying near or touching them.

Relation to conditions in transit.—The development and spread of Rhizopus rot is greatly favored by water on the fruit surface and a way of entrance through the skin. Water may be present on fruit picked and loaded during times of rain or heavy dew or it may condense there because of a moist atmosphere in the storage room or car and fluctuations in the car or storage-room temperature. A way of entrance for the threads produced when spores germinate may be supplied by injuries resulting from careless handling prior to loading or in transit or from shifting and breakage due to improper stowing of the load. While there may be some danger of loss from Rhizopus rot when injuries are few, it can not be too often emphasized that the danger is much greater when they are many. A product which has suffered from careless handling of any sort is much more liable to attack not only in transit but after arrival on the market than one which has been carefully handled at every step.

Importance of temperature.—The danger of attack by the Rhizopus fungus in transit is greatly increased by the presence of skin breaks and moisture. Whether or not the attack takes place depends almost entirely on the temperature at which the fruit is held. For this rot the critical temperature or danger point is 50° F. Two or three degrees below this the product is fairly safe, provided the cooling to 50° F. or below is done as soon as possible after the fruit is loaded or stored and the temperature specified is maintained during all of the transit or storage period. Experiments with peaches conducted by the Department of Agriculture have shown that with the usual number of days in transit for most peach shipments, the Rhizopus fungus can produce little or no damage at 50° and none at 45° F. Whether it can make any start whatever at 45° F. seems to be determined mainly by the maturity of the fruit, since at that temperature it produces evident rot in 6 days on ripe peaches and not until the end of 12 days on green ones.

The experiments showed also that once the rot gets started it will continue to develop at a temperature (45° F.) considerably lower than that required for the beginning of rot at new places (50° F.). For this reason delay in cooling, due either to the loading of warm fruit or to failure to ice cars promptly, is always risky, as it gives opportunity for the rot to get started and so increases the probability of damage by it. By giving the fungus a longer time in which to work the delay aggravates conditions that already exist or causes others to arise which would not have arisen if the car had moved on time.

Losses.—The extent of the damage caused by this rot in transit is well shown by the Federal inspection reports. In 1919, out of 1,644

cars of peaches examined (originating in 17 States), 212 showed Rhizopus rot to the extent of about 8 per cent, or an average of 1 per cent for the whole number inspected. In general, the loss was greater in cars from the West and Northwest than in cars from the East and South, although it was sometimes considerable even in cars from the South. Cars from certain States showed losses as follows: 50 from Colorado, 8 per cent; 63 from Utah, nearly 3 per cent; 8 from California, 20 per cent; 29 from Washington, 10 per cent; and 28 from Georgia, 12 per cent.

Effect of precooling.—Precooling does much to obviate the danger of attack by Rhizopus and other fungi, as is shown by tests made in the Northwest with prunes and cherries. Cherries precooled, then held in an iced car, showed after 5 days of such storage 2.2 per cent of decay; after 10 days, 6.6 per cent; and after 15 days, 9.8 per cent. Similar lots similarly stored, but not precooled, showed at the end of 5, 10, and 15 days, respectively, 3.2, 9.2, and 13.5 per cent decay. Results equally striking, or even more so, were obtained with prunes and with both prunes and cherries in tests which compared the effect of delayed and immediate shipment and delayed and immediate precooling.[5]

RUSSET OF PLUMS AND PRUNES

Cause.—In doubt.

Symptoms and significance.—The signs of this disease are irregular, rough, russeted spots anywhere on the surface of the fruit. Nothing is known definitely as to the cause of them. They are thought to be due to the combined action of aphids, a surface-growing fungus, and weather conditions, possibly frost.

Russet is of importance merely as a blemish.

SCAB OF PEACHES

Cause.—A fungus (*Cladosporium carpophilum*).

Place of origin.—The fungous disease known as scab originates in the orchard. It makes a rather general attack there on leaves, twigs, and fruit, but is of most importance on the fruit.

Description of the disease.—On the leaves scab is characterized by brown spots in which the tissue dries up and finally drops out, leaving circular holes. It is not an important leaf disease. On the young twigs it appears as roughly circular yellowish brown blotches with a dark-gray to bluish border. The fungus here usually affects only the outer layer, but may girdle and kill the twig. It winters over on the twigs, producing the minute bodies called spores which spread the disease through the orchard.

On the fruit scab occurs as small circular spots, olive green to black in color, which affect only the skin and a shallow layer of flesh underneath. (Fig. 6.) These spots may occur anywhere on the fruit, but are usually confined to the side that is uppermost as it hangs on the tree. When infection is severe the spots coalesce to form large dark sooty areas, and the fruit becomes dwarfed or misshapen owing to the formation of a protective layer of cork under

[5] See footnote 3 for a list of publications giving further information on this subject.

the diseased area. Cracks may be formed by the breaking of this protective layer and a way opened for infection by the brown-rot fungus, by Rhizopus, or by blue mold. In dry seasons the disease is very light, occurring in the form of separate spots which blemish the fruit but do not greatly affect its market value. In wet seasons it may become so serious, owing to the coalescence of the spots and subsequent cracking, that the whole crop is unmarketable.

Losses.—Of the diseases of the fruit of the peach, scab is second only to brown-rot in economic importance. In some seasons the loss for certain sections has been estimated at 10 per cent of the crop, while for the whole United States the total annual loss is often considerable. Of 1,644 cars of peaches examined in 1919 by Federal inspectors, 166 from 12 States of the East and South showed scab to the extent of about 15 per cent, or an average of about 2 per cent for the whole number of cars examined. No scab was reported in shipments from the West or Northwest or from Michigan or New York. Scab is rare in the central portion of Georgia, but quite prevalent in

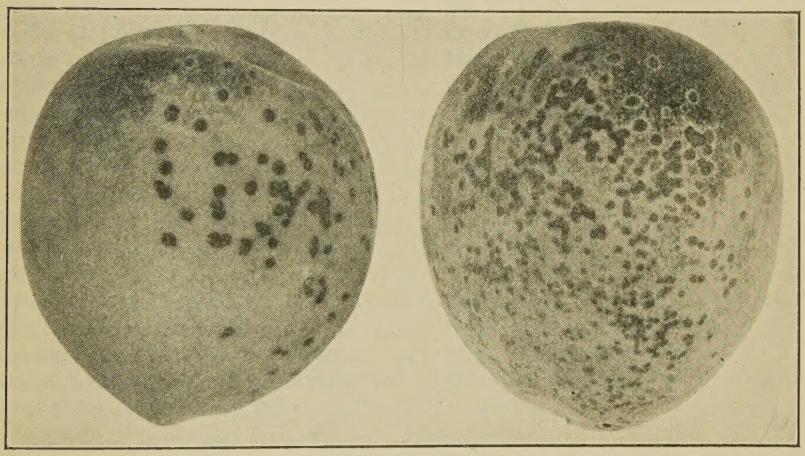

FIG. 6.—Scab of peach

the so-called mountain peach orchards of the Blue Ridge and the Allegheny Mountains.

Control.—Scab is strictly an orchard disease and does not develop or spread in transit or storage. It can be controlled by spraying with self-boiled lime-sulphur or by dusting with finely ground sulphur.[6]

SPRAY INJURY

Cause.—Arsenate of lead and other sprays.

Relation to orchard conditions.—The injury appears on the side or at one end of the fruit as dry browned or blackened areas which are frequently accompanied by severe cracking of the skin and the

[6] For further information on this subject, see the following publications: U. S. Dept. Agr. Bul. 395, Peach Scab and Its Control, by G. W. Keitt; Farmers' Bulletin 440.

underlying flesh. It is commonly nothing more than a severe blemish, although on account of the cracks it may open a way for the entrance of decay fungi, particularly the brown-rot fungus.

The condition here described most often is caused by the arsenate of lead solution used for the control of the curculio and is usually confined to orchards where the solution used was too strong or was applied in such a way as to drench the fruit. It may also be caused by making the application in bright sunlight during extremely hot weather.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

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